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Even well-studied groups of alien species might be poorly inventoried: Australian *Acacia* species in South Africa as a case study

Nkoliso Magona[1,2], David M. Richardson[1], Johannes J. Le Roux[1], Suzaan Kritzinger-Klopper[1], John R.U. Wilson[1,2]

1 *Centre for Invasion Biology, Department of Botany and Zoology, Stellenbosch University, Matieland 7602, South Africa* **2** *South African National Biodiversity Institute, Kirstenbosch Research Centre, Claremont 7735, South Africa*

Corresponding author: *John R. U. Wilson* (john.wilson2@gmail.com)

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Abstract

Understanding the status and extent of spread of alien plants is crucial for effective management. We explore this issue using Australian *Acacia* species (wattles) in South Africa (a global hotspot for wattle introductions and tree invasions). The last detailed inventory of wattles in South Africa was based on data collated forty years ago. This paper aimed to determine: 1) how many Australian *Acacia* species have been introduced to South Africa; 2) which species are still present; and 3) the status of naturalised taxa that might be viable targets for eradication. All herbaria in South Africa with specimens of introduced Australian *Acacia* species were visited and locality records were compared with records from literature sources, various databases, and expert knowledge. For taxa not already known to be widespread invaders, field surveys were conducted to determine whether plants are still present, and detailed surveys were undertaken of all naturalised populations. To confirm the putative identities of the naturalised taxa, we also sequenced one nuclear and one chloroplast gene. We found evidence that 141 Australian *Acacia* species have been introduced to South Africa (approximately double the estimate from previous work), but we could only confirm the current presence of 33 species. Fifteen wattle species are invasive (13 are in category E and two in category D2 in the Unified Framework for Biological Invasions); five have naturalised (C3); and 13 are present but there was no evidence that they had produced reproductive offspring (B2 or C1). DNA barcoding provided strong support for only 23 taxa (including two species not previously recorded from

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South Africa), the current name ascribed was not supported for three species and, for a further three species, there was no voucher specimen on GenBank against which their identity could be checked. Given the omissions and errors found during this systematic re-evaluation of historical records, it is clear that analyses of the type conducted here are crucial if the status of even well-studied groups of alien taxa is to be accurately determined.

Keywords
Biological invasions, herbaria, inventory, invasive species, management plan, tree invasions, alien species lists

Introduction

Every country needs up-to-date lists of introduced species to ensure that management actions are directed appropriately to deal with taxa at all stages of the introduction-naturalisation-invasion continuum (Latombe et al. 2017, McGeoch et al. 2012, Regan et al. 2002). Several types of errors and biases typically exist in such species lists. These include: insufficient survey information, inappropriate data resolution, undocumented data, inaccessible data, lack of sufficient information on native range distribution, incomplete information, misidentifications, unresolved ambiguities in the nomenclature, and un-described taxa (Latombe et al. 2017, McGeoch et al. 2012, Regan et al. 2002). For plants, sources of these errors and biases in the published literature, in museums, and in herbaria need to be assessed to create more comprehensive, accurate and reliable databases to inform management.

Australian *Acacia* species (wattles) are a good group to address the dimensions of these problems because: 1) introductions and plantings of species in this group have been fairly well documented; 2) wattles are amongst the most widely transferred tree species and well-studied invasive plant species in the world; and 3) wattles are often a priority for management (Marais et al. 2004), given the substantial negative impacts they can cause and the difficulties of controlling established invasions (Wilson et al. 2011).

Wattles have been introduced to many parts of the world for many purposes (Le Maitre et al. 2002, Kull and Tassin 2012) and they have played a major role in improving the livelihoods of communities (Kull et al. 2011, van Wilgen et al. 2011) and in economic growth (Griffin et al. 2011, Richardson et al. 2011). Despite these benefits, some wattle species have also become widespread invaders, threatening biodiversity by transforming ecosystems (Le Maitre et al. 2000, 2011).

Throughout this paper, we use the terms "Australian *Acacia* species" or "wattles" to refer to species formerly grouped in *Acacia* subgenus *Phyllodineae*, although several of these species (e.g. *A. koa* and *A. simplex*) do not actually have an Australian native range. We do not, however, consider species formerly grouped in other subgenera (e.g. even though *A. bidwilli* was formerly grouped in *Acacia* subgenus *Acacia*, is native to Australia and has been recorded as being introduced to South Africa, it is not part of this analysis). Richardson et al. (2011) estimated that of the 1022 wattle species formally described as of October 2010, at least 38% of these are known to have been moved by humans to areas outside their native ranges, at least 71 have become naturalised, and at

least 23 have become invasive (i.e. have spread over substantial distances from planting sites) (see also Rejmánek and Richardson 2013).

Knowledge of the introduction history of these species is crucial for understanding and predicting their performance (Wilson et al. 2011) and to guide management strategies (van Wilgen et al. 2011). The long history of introductions and widespread dissemination of Australian *Acacia* species around the world has created opportunities to investigate factors that drive the success and failure of introductions, and to determine how native species respond to such events (Castro-Díez et al. 2011, Richardson et al. 2011).

South Africa has a long history of wattle introductions. Several species (notably *A. cyclops*, *A. longifolia* and *A. saligna*) were introduced in the early 18th century by the Cape Colonial Secretary to stabilise dunes near Cape Town (Ross 1975, Poynton 2009); and, a few decades later, several species, e.g. *A. decurrens*, *A. mearnsii*, and *A. melanoxylon*, were introduced for timber production (Poynton 2009). Where these species were planted for forestry, native vegetation was removed to allow the acacias to establish without competition (Richardson and Rejmánek 2011). In the early 19th century, several other species were introduced for ornamental purposes, e.g. *A. baileyana*, *A. elata*, and *A. podalyriifolia* (Donaldson et al. 2014a, b). As a result of this long and varied history, South Africa has the greatest recorded diversity of Australian *Acacia* species introductions and the most widespread wattle invasions of anywhere in the world (Richardson et al. 2011, Richardson and Rejmánek 2011, Rejmánek and Richardson 2013).

The history of wattle species introduced and planted for forestry purposes in South Africa was reviewed by Poynton (2009). However, the information on which this assessment was based was collated in the 1970s and needs updating. For example, recent surveys have shown that some species are much more abundant and widespread than previously thought (e.g. *A. paradoxa*; Zenni et al. 2009), and several species that were not listed by Poynton (2009) are now invasive (e.g. *A. stricta*; Kaplan et al. 2014).

Despite several decades of intensive management of invasive wattles in South Africa (van Wilgen et al. 2011, 2016), we know little about species other than those with substantial commercial value and those that are well-established invaders. What is known, however, is that invasions of Australian *Acacia* species are still increasing in geographical extent, abundance, and magnitude of impact (Henderson and Wilson 2017). Even the most widespread invasive species have not reached all potentially invasible sites (Rouget et al. 2004) and many naturalised species only began spreading recently (e.g. Zenni et al. 2009, Kaplan et al. 2012, 2014). Rouget et al. (2016) quantified different aspects of this "invasion debt" for wattles and found that southern Africa has a large invasion debt. If the invasion debt were realised, there will be a substantial escalation in the overall ecological and economic impacts of wattles (Richardson et al. 2015).

Richardson et al. (2011) reported that about 70 species of Australian *Acacia* species are known to have been introduced to South Africa, some as early as the 1830s (Adamson 1938, Poynton 2009). Fourteen species are currently considered invasive in the country (Rejmánek and Richardson 2013). There are also records of naturalised populations of *A. adunca*, *A. cultriformis*, *A. fimbriata*, *A. pendula*, *A. viscidula*, (Wilson et al. 2011, van Wilgen et al. 2011) and there are localised populations of what has

been termed "*A. retinodes*" (which is likely *A. provincialis* – see Table 1) and *A. ulicifolia* (Wilson et al. 2011, van Wilgen et al. 2011). The identification of these naturalised species remains to be verified, and the status of other species reported in the country is unknown. This study therefore set out to determine: 1) how many Australian *Acacia* species have been introduced to South Africa; 2) which species are still present; and 3) what is the extent of naturalised populations.

Methods

Creating a list of species that have been introduced into South Africa

We reviewed formal literature sources (e.g. Poynton et al. 2009; Street 1962), student theses, and unpublished records documenting Australian acacias in South Africa. All relevant herbaria, museums, and botanical gardens in South Africa with specimens or collections of Australian *Acacia* species were also visited or consulted. Literature and online databases were searched using the genus and species name as a search term to collate information on specimens from other herbaria around the world that were previously recorded in South Africa (e.g. www.worldwidewattle.com; http://newposa.sanbi.org; www.gbif.org; and www.ildis.org/). The dataset was expanded with data from other sources that list introduced species distributions in southern Africa, including: 1) the Southern African Plant Invaders Atlas (SAPIA, Henderson and Wilson 2017); 2) I-Spot (http://www.ispot.org.za/); and 3) the National Herbarium Computerized Information System (PRECIS online database http://newposa.sanbi.org/; Morris and Glen 1978). Locality records from herbaria data were compared with records in literature sources, databases and experts to obtain updated locality records. Data collected from different sources were filtered and duplicates were removed.

During herbaria visits, we followed a standard protocol for dealing with records of Australian acacias (Fig. 1). Records with precise coordinates were noted and added to the locality list. Google Earth was used to find the likely locality of the *Acacia* plants. Landowners and managers were contacted, and field surveys were conducted to search for plants. For records with imprecise locality description and no coordinates, the source of the record was consulted.

Determining which species are still present

After compiling the list of introduction sites for wattles in South Africa, we conducted field surveys to confirm whether species were still present. We also specifically looked for locations where many species had been cultivated (e.g. arboreta and forestry trial plantations) to determine whether other taxa that have not been formally recorded were present. In cases where a location was provided but precise co-ordinates were not given, we consulted relevant officials (e.g. local conservation officers).

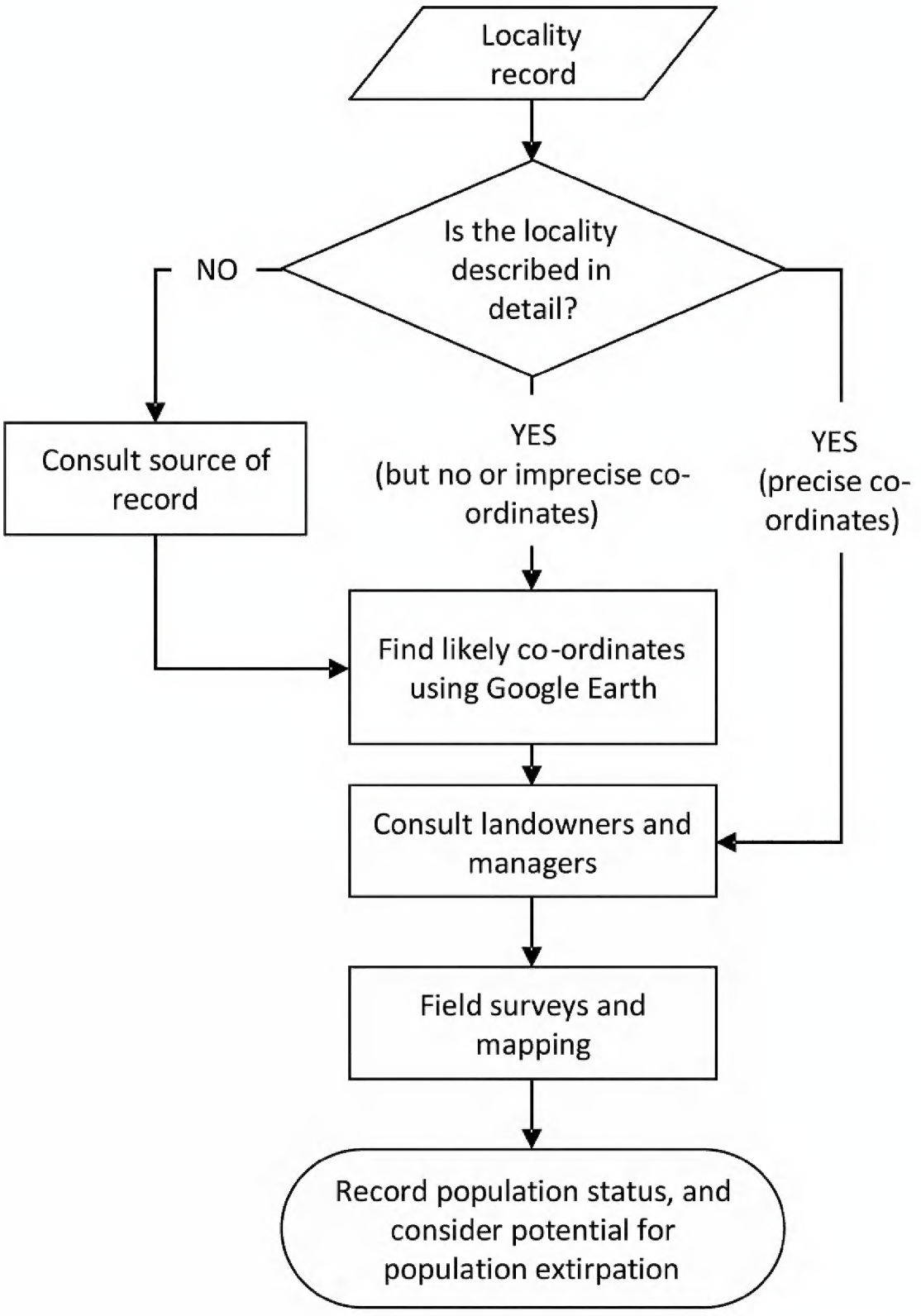
Locality record
Is the locality described in detail?
NO
YES (but no or imprecise co-ordinates)
YES (precise co-ordinates)
Consult source of record
Find likely co-ordinates using Google Earth
Consult landowners and managers
Field surveys and mapping
Record population status, and consider potential for population extirpation

Figure 1. The protocol used in this paper for dealing with records of Australian *Acacia* species in South Africa. The protocol resulted both in an inventory of species in South Africa and recommendations for incursion response.

When comparing different lists, it was also possible to determine the types of errors (e.g. human error and species identification) in the lists (e.g. Jacobs et al. 2017). To this end, we examined 214 herbarium specimens and specifically checked the identities for 59 of these.

Many *Acacia* species are morphologically very similar and it is difficult to identify some taxa based on herbarium specimens and morphology alone. If the identity of a taxon collected in the field was not known or, if the identity of a taxon had not

previously been confirmed via molecular approaches, we used DNA sequencing to verify identities. We sequenced two gene regions, the plastid *psb*A-*trn*H intergenic spacer and the nuclear external transcribed spacer region (ETS), for comparison against existing molecular data (Miller et al. 2016). DNA was extracted from silica-dried leaf material from selected taxa (Suppl. material 1) using the cetyltrimethylammonium bromide (CTAB) method as described by Doyle and Doyle (1990). *psb*A-*trn*H was amplified using the primers psbA (5'-GTT ATG CAT GAA CGT AAT GCT C-3') and trnH$^{(GUG)}$ (5'-CGC GCA TGG ATT CAC AAT CC-3') and the following polymerase chain reaction (PCR) conditions: Initial denaturation at 80 °C for 5 min; followed by 35 cycles of denaturation at 94 °C for 30 sec, annealing at 60 °C for 30 sec, and extension at 72 °C for 1 min. A final elongation step was done at 72 °C for 10 min. Each 30 µl reaction contained ca. 300 ng of genomic DNA, 200 µM of each dNTP (Thermo Scientific, supplied by Inqaba Biotec, Pretoria, South Africa), 10 pmoles of each primer, 0.3 U Taq DNA polymerase (Kapa Biosystems, supplied by Lasec, Cape Town, South Africa), PCR reaction buffer and 2 mM $MgCl_2$. ETS genes were amplified using the primers ETS-AcR2 (5'-GGG CGT GTG AGT GGT GTT TGG-3') and ETS-18S-IGS (5'-CAC ATG CAT GGC TTA ATC TTT G-3') and the following PCR conditions: Initial denaturation at 94 °C for 3 min; followed by 30 cycles of denaturation at 94 °C for 60 sec, annealing at 60 °C for 60 sec, and extension at 72 °C for 2 min. A final elongation step was done at 72 °C for 10 min. Each 30 µl reaction contained ca. 300 ng of genomic DNA, 200 µM of each dNTP (Thermo Scientific, supplied by Inqaba Biotec, Pretoria, South Africa), 10 pmoles of each primer, 0.3 U Taq DNA polymerase (Kapa Biosystems, supplied by Lasec, Cape Town, South Africa), PCR reaction buffer and 1.25 mM $MgCl_2$. PCR products for both gene regions were purified using the QIAquick® PCR Purification Kit (Qiagen, supplied by WhiteHead Scientific, Cape Town, South Africa) and sequenced using the ABIPRISM BigDye Terminator Cycle Sequencing Ready Reaction kit and an automated ABI PRISM 377XL DNA sequencer (PE Applied Biosystems, Foster City, CA, USA). DNA sequence data were aligned and edited using the bio edit version 7.0.5.3 (Hall 1999) followed by manual editing. We used BLAST searches to assign a taxonomic rank based on the similarity of individual gene sequences to exisiting data, using the NCBI's GenBank database (http://blast.ncbi.nlm.nih.gov/Blast). Taxa where putative field identifications matched those of Genbank voucher specimens and that blasted with high DNA sequence similarities (≥ 99%) for at least one gene region, were considered correctly identified. Discrepancies between putative field identifications and BLAST results were condisered as representing unresolved taxonomies, unless both genes retrieved the same taxon with high DNA sequence similarity and high statistical support (E=0). Identity was also considered to be correct when Blast results retrieved a species with high DNA sequence similarity (≥ 99%) and statistical support (E=0) for both gene regions (even if there was no putative field identification or link to planting records).

The introduction status of *Acacia* species present in South Africa

The observed populations of *Acacia* species were assigned an introduction status following the Unified Framework for Biological Invasions (Appendix 1; Blackburn et al. 2011), as interpreted and elucidated for trees by Wilson et al. (2014). We conducted field surveys to search for species at previously known or recorded sites obtained from herbarium records and literature sources. Google Earth and Google Street View were used to initially search for trees using the geographic coordinates on herbarium records [see Visser et al. (2014) for discussion on the use of Google Earth in the study of tree invasions]. This was useful for preparing for surveys and for initial work. A summary of the status of each naturalised population was prepared following the recommendations of Wilson et al. (2014).

Results

We found evidence that 141 Australian *Acacia* species have been introduced to South Africa (Table 1). For 112 species there is a literature record (this is the only evidence available for 56 species), for 81 species there is a herbarium records (this is the only evidence for 27 species), and 23 species have been confirmed using a molecular approach (this is the only evidence for 2 species).

Of these 141 species, we could confirm the presence of only 33 species (Table 1, see Fig. 2 for images of some of these). In terms of Blackburn et al.'s (2011) Unified Framework for Biological Invasions (see Appendix 1 for a full description of the categories), 13 of these species are in category E, two are in category D2 (i.e. there are 15 invasive species). Five species are naturalised but not yet invasive (category C3). We found no evidence that the remaining 13 species have produced reproductively active offspring in South Africa; these taxa thus fall in category B2 or C1. Status reports on the five naturalised and one invasive species that had not previously been studied in detail are presented in Appendix 2.

The estimate of 141 species is approximately double that of the previous estimate of 70 species (Richardson et al. 2011). These additional species include taxa not previously known from outside Australia (*A. acuaria*, *A. latipes*, *A. leptospermoides*, *A. salicifolmis*, *A. ulicina*, and *A. uncifera*; Richardson et al. 2011).

We found one error and five misspellings on herbarium labels, these errors being perpetuated in subsequent literature sources. There were an additional three misspellings in literature sources (Table 2).

Only 23 species identities were confirmed either in this study or previously using a molecular approach (Table 1; Suppl. material 1). Of these two species (*A. hakeoides* and *A. ramulosa*) had not previously been recorded as having been introduced. For three species with a putative field identification, the molecular results did not correspond to the voucher specimens for the same species on GenBank (*A. adunca*, *A. fimbriata*, and *A. floribunda*). For a further three species, there was no voucher specimen on GenBank

Table 1. The presence of Australian *Acacia* species in South Africa based on herbarium specimens, molecular identification, records from historical literature sources, and the current status of populations from field sampling. Species names are as per the Plant List (The Plant List 2013, accessed 1 March 2018), with synonyms on herbarium records and literature records updated as appropriate (see notes). Herbarium records in South Africa not available on-line at http://newposa.sanbi.org/ (as of 1 March 2018) are marked with asterisks *, and details provided in Suppl. material 2. Molecular confirmation of taxonomic identities of acacias in South Africa was either based on existing records in Genbank or obtained from this study (see Suppl. material 1 for details of the results from this study). If the molecular work provided some support for the identification but not unequivocal support, the confirmation is noted as "probable". Where the putative identity did not match records of that species on Genbank (where available), then it is noted as "tested but likely to be a different species". The literature records of presence are based on the sources listed in the notes. Current status for species found during the field surveys is as per the Unified Framework for Biological Invasions (Blackburn et al. 2011; See Appendix 1 for details, and Suppl. material 3 for the range sizes of all naturalised and invasive species). The current status of species whose presence could not be unequivocally established during field visits are indicated as "not known". Several additional species have been recorded from neighbouring countries but not in South Africa as far as we know [*Acacia adsurgens*, *A. cowleana*, and *A. crassicarpa* (Poynton 2009)].

***Acacia* species**	**Herbarium record**	**Molecular confirmation**	**Literature record of presence**	**Current status**	**Locations recorded**
A. acinacea Lindl.	yes*	no	yes[b]	Not known	Cape Peninsula
A. acuaria W.Fitzg	yes*	no	no	Not known	University of Pretoria
A. acuminata Benth.	yes*	yes	yes[a,b]	B2	Paarl, Uitenhage, Knysna, Stutterheim, Robertson, Lichtenburg, Malmesbury
A. adunca G.Don	yes	tested, but likely to be a different species	yes[b,c]	C3	Paarl, Pretoria, Johannesburg
A. alata R.Br.	yes*	no	yes[b]	Not known	Johannesburg
A. ampliceps Maslin	no	no	yes[a]	Not known	Malmesbury
A. ancistrocarpa Maiden & Blakeley	no	no	yes[a]	Not known	Malmesbury
A. aneura Benth.	yes*	probable	yes[a,b]	B2	Zoutpansberg, Lichtenburg, Paarl, Malmesbury
A. argyrophylla Hook.	yes*	no	yes[b]	Not known	Johannesburg
A. aspera Lindl.	yes*	no	yes[b]	Not known	Pretoria
A. aulacocarpa Benth.	no	no	yes[b]	Not known	Johannesburg
A. auriculiformis Benth.	no	no	yes[a,b]	Not known	Malmesbury
A. baileyana F.Muell.	yes	yes	yes[b,c]	E	Multiple
A. binervata DC.	yes*	no	yes[b]	Not known	Cape Peninsula, Pretoria, Johannesburg
A. binervia (Wendl.) J.F.Macbr.	yes*	no	yes[b]	Not known	Pretoria
A. bivenosa DC.	no	no	yes[a]	Not known	Malmesbury
A. brachybotrya Benth.	yes*	no	yes[b]	Not known	Johannesburg

***Acacia* species**	**Herbarium record**	**Molecular confirmation**	**Literature record of presence**	**Current status**	**Locations recorded**
A. brachystachya Benth.	yes*	no	yes[a,b]	Not known	Pretoria, Malmesbury
[1]*A. browniana* Wendl.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. burrowii Maiden	no	no	yes[a]	Not known	Malmesbury
A. calamifolia Lindl.	yes*	no	yes[b]	Not known	Pretoria
A. calcicola Forde & Ising	no	probable	yes[a]	B2	Malmesbury
A. cambagei R.T.Baker	no	no	yes[a,b]	Not known	Malmesbury
A. cardiophylla Benth.	yes*	no	yes[b]	Not known	Johannesburg, Pretoria
A. celastrifolia Benth.	yes*	no	no	Not known	University of Pretoria
A. cognata Domin	yes*	no	no	Not known	Pretoria
A. colei Maslin & L.A.J.Thomson	no	no	yes[a]	Not known	Malmesbury
A. concurrens Pedley	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. coriacea DC.	no	no	yes[a]	Not known	Malmesbury
A. crassiuscula Wendl.	yes	no	no	B2	Newlands forest
A. cultriformis G.Don	yes	yes	yes[b,c]	C3	Pretoria, Johannesburg, Middelburg, Grahamstown
A. cyclops G.Don	yes	yes	yes[b,c]	E	Multiple
A. dealbata Link	yes	yes	yes[b,c]	E	Multiple
A. deanei (R.T.Baker) M.B.Welch & al.	yes*	no	yes[b]	Not known	Pretoria
A. decora Rchb.f.	yes*	no	yes[b]	Not known	Albany
A. decurrens Willd.	yes	yes	yes[b,c]	E	Multiple
A. difficilis Maiden	no	no	yes[a]	Not known	Malmesbury
[2]*A. difformis* R.T.Baker	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. dodonaeifolia (Pers.) Balb.	yes*	no	no	Not known	Port Elizabeth
A. doratoxylon A.Cunn.	yes*	no	no	Not known	Cape Peninsula
A. drummondii Lindl.	yes*	no	no	Not known	University of Pretoria
A. elachantha M.W.McDonald & Maslin	no	no	yes[a]	Not known	Malmesbury
[3]*A. elata* Benth.	yes	yes	yes[b,c,f]	E	Multiple
A. elongata DC.	yes*	no	no	Not known	Pretoria
A. ericifolia Benth.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. extensa Lindl.	yes*	no	yes[b]	Not known	Johannesburg

Acacia species	Herbarium record	Molecular confirmation	Literature record of presence	Current status	Locations recorded
A. falciformis DC.	no	no	yes[b]	Not known	Cape Town
A. fasciculifera Benth.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. fimbriata G.Don	yes	tested, but likely to be a different species	yes[b,c]	D2	Grahamstown
A. flexifolia Benth.	yes*	no	no	Not known	Johannesburg
A. flocktoniae Maiden	yes*	no	no	Not known	Pretoria, Johannesburg
A. floribunda (Vent.) Willd.	yes*	tested, but likely to be a different species	yes[b]	C1	Johannesburg; Pretoria; Bloemfontein
A. gladiiformis Benth.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. hakeoides Benth.	no	yes	no	B2	Malmesbury, Johannesburg Botanic Gardens
A. harpophylla Benth.	yes*	no	yes[a]	Not known	Malmesbury
A. hemsleyi Maiden	no	no	yes[a]	Not known	Malmesbury
A. holosericea G.Don	no	no	yes[a,b]	Not known	Malmesbury
A. homalophylla A.Cunn. ex Benth.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. howittii F.Muell.	yes*	no	no	Not known	Albany
A. implexa Benth.	yes	yes	yes[d,f]	E	Stellenbosch, Tokai, Wolseley
A. iteaphylla Benth.	yes*	no	yes[b]	Not known	Pretoria
A. ixiophylla Benth.	yes*	no	no	Not known	Johannesburg
A. jonesii F.Muell. & Maiden	yes*	no	yes[b]	Not known	Pretoria
A. julifera Benth.	no	no	yes[a]	Not known	Malmesbury
A. kempeana F.Muell.	yes*	no	yes[a,b]	Not known	Malmesbury, Johannesburg
A. koa A.Gray	yes*	probable	yes[b]	B2	multiple
A. lanigera A.Cunn.	yes*	no	no	Not known	Lydenburg dist.
A. latifolia Benth.	no	no	yes[b]	Not known	The Cape
A. latipes Benth.	yes*	no	no	Not known	Addo Elephant National Park
A. leprosa DC.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. leptocarpa Benth.	no	no	yes[a]	Not known	Malmesbury
A. leptoneura Benth.	yes*	no	yes[b]	Not known	Pretoria
A. leptospermoides Benth.	yes*	no	no	Not known	Pretoria
A. ligulata Benth.	no	no	yes[a]	Not known	Malmesbury
A. lineata G.Don	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. lineolata Benth.	yes*	no	no	Not known	Johannesburg

***Acacia* species**	**Herbarium record**	**Molecular confirmation**	**Literature record of presence**	**Current status**	**Locations recorded**
A. linifolia (Vent.) Willd.	yes*	no	yes[b]	Not known	Pretoria
A. longifolia (Andrews) Willd.	yes	yes	yes[b,c]	E	multiple
A. longissima Wendl.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. lunata G.Lodd.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. maconochieana Pedley	no	no	yes[a]	Not known	Malmesbury
A. macradenia Benth.	no	no	yes[b]	Not known	Cape Peninsula
A. maidenii F.Muell.	no	no	yes[c]	Not known	None noted
A. mangium Willd.	no	no	yes[b]	Not known	Malmesbury
A. mearnsii De Wild.	yes	yes	yes[b,c]	E	multiple
A. melanoxylon R.Br.	yes	yes	yes[b,c]	E	multiple
A. microbotrya Benth.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. monticola J.M.Black	no	no	yes[a]	Not known	Malmesbury
A. multispicata Benth.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. murrayana Benth.	no	yes	yes[a]	B2	Malmesbury
A. myrtifolia (Sm.) Willd.	yes*	no	yes[b]	Not known	Johannesburg, Pretoria
A. neriifolia Benth.	yes*	yes	yes[a,b]	B2	Malmesbury
A. notabilis F.Muell.	no	no	yes[b]	Not known	Not recorded (seed import record only)
[4]*A. obliqua* A.Cunn. ex Benth.	no	no	yes[b]	Not known	Cape Town
A. oswaldii F.Muell.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. oxycedrus Sieber ex DC.	yes*	no	no	Not known	Pretoria
A. paradoxa DC.	yes	yes	yes[b,c]	D2	Devils Peak, Table Mountain, Cape Town
A. pendula G.Don.	yes*	no	yes[b,c]	C1	Middelburg, Excelsior district Delareyville, Lichtenburg, Bloemhof, Kroonstad dist.,Beaufort West
A. penninervis DC.	yes*	no	yes[b]	Not known	Cape Peninsula
A. piligera A.Cunn.	yes*	no	no	C3	Tokai
A. plectocarpa Benth.	no	no	yes[a]	Not known	Malmesbury

Acacia species	Herbarium record	Molecular confirmation	Literature record of presence	Current status	Locations recorded
A. podalyriifolia G.Don	yes	yes	yes[b,c]	E	multiple
A. polybotrya Benth.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. pravissima F.Muell.	yes*	no	yes[b]	Not known	Pretoria
A. prominens G.Don	yes*	no	yes[b]	Not known	Pietermaritzburg, Zoutpansberg, Centurion
[5]*A. provincialis* A.Camus	yes*	[5]no	yes[b,c]	C3	Pretoria, Stellenbosch, Johannesburg, Tokai
A. pruinocarpa Tindale	no	no	yes[a]	Not known	Malmesbury
A. pruinosa Benth.	yes*	no	no	Not known	Cape Peninsula
A. pubescens (Vent.) R.Br.	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. pycnantha Benth.	yes	no	yes[b,c]	E	multiple
A. quornensis J.M.Black	yes*	no	yes[b]	Not known	Johannesburg
A. ramulosa W.Fitzg.	no	yes	no	B2	Malmesbury
A. richii A.Gray	yes*	no	no	Not known	Pretoria
A. rubida A.Cunn.	no	no	yes[b]	Not known	Middelburg
A. saliciformis Tindale	yes*	no	no	Not known	Pretoria
A. salicina Lindl.	yes*	probable	yes[a,b]	B2	Malmesbury, Johannesburg, Gwelo
A. saligna (Labill.) Wendl.	yes	yes	yes[b,c]	E	Multiple
A. schinoides Benth.	yes*	no	yes[b]	Not known	Stellenbosch
A. scirpifolia Meissner	yes*	no	no	Not known	Paarl
A. sclerosperma F.Muell.	no	no	yes[a]	Not known	Malmesbury
A. simplex (Sparrm.) Pedley	no	no	yes[b]	Not known	Not recorded (seed import record only)
A. spectabilis Benth.	no	no	yes[b]	Not known	Johannesburg
A. squamata Lindl.	yes*	no	no	Not known	Suurberg Nature Reserve
A. stenophylla Benth.	no	no	yes[a,b]	Not known	Malmesbury
A. stricta (Andrews) Willd.	yes	no	yes[e]	E	Knysna
A. suaveolens (Sm.) Willd.	no	no	yes[b]	Not known	Cape Town
A. subporosa F.Muell.	yes*	no	no	Not known	Cape Peninsula
A. trinervata DC.	no	no	yes[b]	Not known	Not recorded (seed import record only)

***Acacia* species**	**Herbarium record**	**Molecular confirmation**	**Literature record of presence**	**Current status**	**Locations recorded**
A. truncata Hoffmanns.	no	no	yes[b]	Not known	Cape Town
A. tumida F. Muell. ex Benth.	no	no	yes[a]	Not known	Malmesbury
A. ulicifolia (Salisb.) Court	no	no	yes[b]	C1	Pretoria Cape Peninsula, Transkei
A. ulicina Meissner	yes*	no	no	Not known	Pretoria
A. uncifera Benth.	yes*	no	yes[b]	Not known	Pretoria
A. undulifolia G.Lodd.	yes*	no	no	Not known	Cape Peninsula
A. verniciflua A.Cunn.	yes*	no	yes[b]	Not known	Cape Town, Pretoria
A. verticillata (L'Her.) Willd.	yes*	no	yes[b]	Not known	Pretoria
A. vestita Ker. Gawl.	no	no	yes[b]	Not known	Cape Town
A. victoriae Benth.	no	no	yes[a,b]	Not known	Malmesbury, and as seed
A. viscidula Benth.	yes	yes	yes[b,c]	C3	Pretoria, Grahamstown, Newlands Forest, Cape Town
A. willdenowiana Wendl.	yes*	no	no	Not known	Addo Elephant National Park
A. xiphophylla E.Pritz.	no	no	yes[a]	Not known	Malmesbury

Notes on *Acacia* species

[1]Ponyton (2009) listed *A. ciliata* R.Br., but according to the Plant List, this is a synonym of either *Acacia browniana* or *A. luteola*. Only *A. browniana* is listed here to keep the number of taxa recorded consistent.

[2]Listed as "*A. differmis* (sic)" in Poynton (2009).

[3]Ponyton (2009) also lists *A. discolor* Willd., but this is a synonym of *A. terminalis*, which was misapplied for *A. elata* in South Africa, and so only *A. elata* is included in the list above.

[4]Ponyton (2009) lists *A. obliqua* and this is a valid name on the Plant List, but is not on the World Wide Wattle web-site.

[5]Communication with M. O'Leary (State Herbarium of South Australia) in April 2018 suggests that the name *A. retinodes* Schltdl. has been misapplied and that the taxon that is present in Europe and South Africa is *A. provincialis* A.Camus. As there are currently no sequences of a voucher specimen of *A. provincialis* on Genbank, it was not possible to provide molecular confirmation, but notably the gene regions sequenced showed a close, but not perfect, match to *A. retinodes*, as would be expected if it were *A. provincialis* (Suppl. material 1).

Notes on Literature records

[a]Gibbs (1998) (i.e. the trial on Damara Farm);

[b]Poynton (2009);

[c]Ross et al. (1975);

[d]Kaplan et al. (2012);

[e]Kaplan et al. (2014);

[f]Meek et al. (2010).

Table 2. Methodology followed in determining errors in lists of *Acacia* species in herbaria and in literature sources.

Errors	Explanatory questions	Method	Results
Human error	How many herbarium specimens had been misidentified?	All herbarium specimens of *Acacia* species were examined for correct identification. If a specimen was suspected to have been misidentified, the identification was verified using identification guides (e.g. online database, reference books), experts, or molecular DNA barcoding. The total number of herbarium vouchers examined and misidentifications were counted. Furthermore, any known case of species being misidentified in the literature was noted.	Only one species was found to have been clearly misidentified: *A. koa* was misidentified as *A. floribunda*
	How many entries had incorrect spellings?	A search was conducted of literature sources and online databases to determine the total number of *Acacia* species which had their names changed. When examining herbarium specimens, the number of times the records had been renamed (i.e. old names crossed out and new names recorded) was counted. To determine the number of times *Acacia* species have had their names changed, literature sources and databases (www.theplantlist.org) were used. The Plant List was used as the source for recognised names. The number of records using old names (not the currently accepted name) was counted.	Five species names on herbarium specimens were misspelled: *A. aulacocarpa as A. aulocarpa*; *A. drummondii* as *A. drummardii*; *A. ulicifolia as A. ulicifolium*; *A. iteaphylla as A. itheaphylla;* *A. verticillata as A. verticulata.* Three additional errors were found in literature sources: *A. ulicifolia* as *A. aculeatissima;* *A. aulacocarpa* as *A. aulacorpa*; *A. drummondii* as *A. drummardii*.
Which errors have been perpetuated?		The identified errors were assessed for presence in multiple data sources to determine whether an error has been repeated. The primary source of the identified errors was also assessed by conducting a literature search using the specific error as the search term.	Both the misidentification of *A. koa* and three cases of the misspelling in herbarium specimens (of *A. ulicifolia*, *A. iteaphylla*, and *A. verticillata*) were found to have been perpetuated in literature sources.

Errors	Explanatory questions	Method	Results
Resolution of data and scaling of "alien range"	For how many records was the resolution of data too coarse to be useful?	Field surveys were conducted on reported population localities from SAPIA, herbaria and literature. The number of records for which the resolution of data (e.g. quarter-degree grid cell, town or region) was too coarse to allow individuals to be located was recorded. The data from SAPIA, herbaria and literature was compared with the survey results to provide a fine resolution locality.	Using historical data was not accurate as the resolution was too coarse (recorded at the scale of quarter-degree cells). Using such data was unreliable for locating and assessing the extent of species spread. We mapped the species at finer scales to avoid such issues.
Data and knowledge not documented	How many records were not documented?	New locality records were followed up in field surveys to establish the current status of species localities. The number of records that are only the result of undocumented expert knowledge and surveys were counted. Furthermore, some species identification fliers were distributed in surveyed areas to solicit new species sightings. Any new sightings resulting from the public sightings were counted.	Two localities found. 18 putative *Acacia* species were recorded at Damara Farm and one species at the University of the Free State.

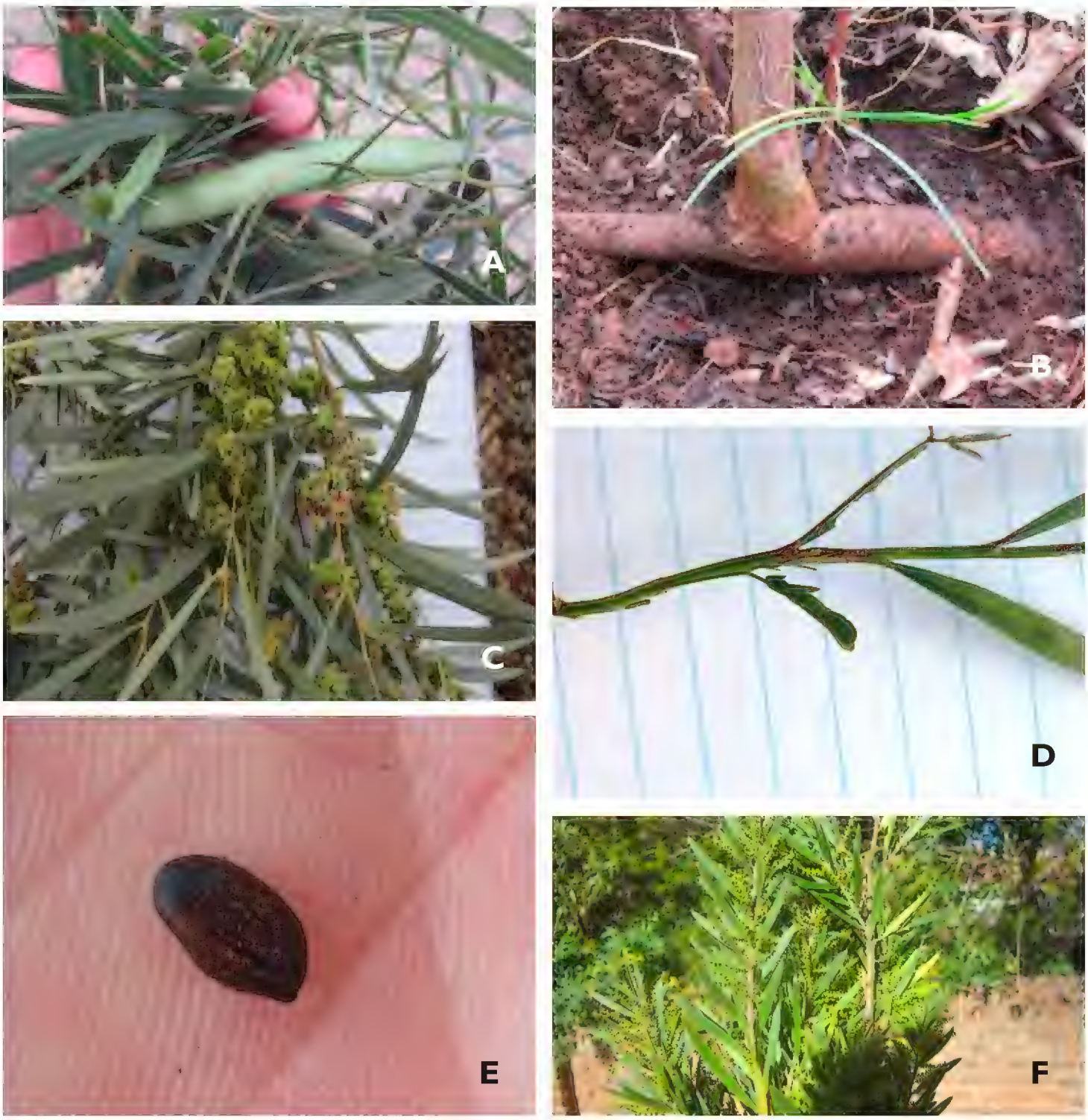

Figure 2. Examples of Australian *Acacia* species found in this study. **A** *Acacia salicina* with green pods in the Johannesburg Botanical Gardens **B** *A. viscidula* root sucker in a naturalised population in Newlands, Cape Town **C** *A. pendula*. Galls from a biological agent (*Dasineura dielsi*) released to control *A. cyclops* are visible in Bloemfontein **D** *A. provincialis* seedling showing juvenile bipinnate leaves attached to the stem and to the ends of the first few phyllodes, there are no bipinnate leaves on older phyllodes **E** A seed of *A. piligera* collected at Tokai, Cape Town **F** A planted individual of *A. floribunda* showing phyllodes and flower spikes in Johannesburg. Photos A–C, E, F: Nkoliso Magona; D: John Wilson

and so it was not possible to obtain molecular support for their putative identification (*A. piligera*, *A. provincialis*, and *A. ulicifolia*).

Notably, when this manuscript was under review, it was pointed out to us by Martin O'Leary, State Herbarium of South Australia, that *A. retinodes* had frequently been misapplied to *A. provincialis* in other countries, and, on further investigation, this appears to have been the case in South Africa as well.

Discussion

Before this study, 70 Australian *Acacia* species were known to have been introduced to South Africa (Richardson et al. 2011). We found evidence that another 71 species had been introduced to the country. Of the revised list of 141 species for which records exist for introduction to, or presence in, South Africa (Table 1), we could confirm that at least 33 species are still present in the country.

There were four major reasons for the discrepancy between the list of species recorded as having been introduced to South Africa and the list of species confirmed to be still present in the country. First, during the survey, we came across an old experimental forestry trial set up to identify species suitable for dry-land agroforestry (Damara Farm in the Western Cape; see Suppl. material 4). Thirty-three Australian *Acacia* species were reportedly planted at Damara Farm (Gibbs 1998), of which we found 18 putative taxa (based on morphology and molecular analysis). None of these taxa has naturalised.

Second, specimens of several species are present in the National Herbarium in Pretoria but had not been included in previous lists because the herbarium records had not yet been digitised.

Third, species might no longer be present at their original sites of introduction. Many of the records (particular herbarium records that have not yet been digitised) were from historical forestry plantings. When we followed up, we found that many of these planting were no longer present — they had been transformed for infrastructure development, agriculture, or other forms of land use. Most cases, where listed species are no longer present, were within the municipal areas of the cities of Johannesburg and Pretoria that have been converted to stock farms. For example, all available records of *A. cultriformis* that were assessed in Gauteng Province are now under various forms of agriculture, while several records of other species in Poynton (2009) referred to arboreta that no longer exist.

Fourth, species might not have survived at sites of initial introduction due to unfavourable climatic conditions or biotic pressures; Poynton (2009) noted that most introduced *Acacia* species were grown in trial plantations, many of which did not survive.

Finally, it is possible that, despite our best efforts, our searches were inadequate to (re)locate some species. We suspect this is unlikely to be a major cause, as Australian *Acacia* species have been extensively studied and managed in South Africa, and as the taxa are often quite distinct from the native flora. Some "missing" species might feasibly be surviving in soil-stored seed banks (seeds of many wattle species can retain viability in the soil for several decades; Richardson and Kluge 2008). However, due to the fact that many herbaria specimens and literature reports lacked detailed locality data (longitude and latitude coordinates), it is possible that we simply were not looking in the right place.

Notably, however, there may be other localities like Damara Farm where multiple species have been cultivated and potentially still exist. Poynton (2009) noted that many old trial plantations were left unmanaged due to the closure of forest stations; records of these sites might not be reflected in the information sources that we consulted.

Whatever the reasons for discrepancies in past estimates of wattle introductions in South Africa, it is clear that there is a high invasion debt for Australian *Acacia* species in the country (Rouget et al. 2016). If this debt were paid, it would lead to a substantial escalation in the extent of invasions and overall ecological and economic impacts of the group (Richardson et al. 2015). There appears to be no clear set of life-history features, or syndromes of traits, that separate invasive from non-invasive *Acacia* species (Gibson et al. 2011), nor is there a clear phylogenetic signal for invasiveness in the genus (Miller et al. 2017). This suggests that factors associated with propagule pressure and residence time have been the dominant drivers of invasiveness in this genus in South Africa. This highlights the importance of dealing with nascent invaders before population sizes and spatial extent are sufficiently large to drive self-sustaining invasions.

One way of reducing this invasion debt is through proactive management approaches, e.g. the detection, identification, assessment, and control of naturalised populations before they are widespread invaders. Some of the naturalised populations of Australian acacias in South Africa occur only at a few sites and so eradication is possible, but for some species, *A. cultriformis* specifically, it is likely that they are present at other locations that were not detected in this study. During the field visits in the cities of Bloemfontein and Johannesburg, people that had *A. cultriformis* in their gardens reported that this species was present in many gardens in neighbouring areas. As this species has been widely planted, it is likely that the extensive seed bank and high climatic suitability (Motloung et al. 2014) could make it a high invasion risk (Wilson et al. 2011). Of the naturalised species that were detected in this study, *A. cultriformis* is the only one for which nation-wide eradication is likely to be not feasible (given the problems with locating all horticultural plantings).

Some of the taxa might also have been prevented from spreading due to the impact of biological control agents released to target the widespread Australian *Acacia* species. In this study, the biological control agents *Dasineura dielsi* (target species: *A. cyclops*) and *Trichilogaster acaciaelongifoliae* (target species: *A. longifolia*) were observed on both *A. floribunda* and *A. pendula*. *Dasineura dielsi* has previously been recorded on *A. implexa*, *A. melanoxylon*, *A. longifolia* and *A. saligna* (Impson et al. 2009, Kaplan et al. 2012). It is likely that the agents reduced seed production in a variety of introduced wattles, and potentially reduced the rate of spread of populations, though it is very unlikely they have resulted in the extirpation of any populations if there were no other management or land-use change.

Unlike other taxonomic groups of alien plants, where there are many misidentified herbarium records (e.g. *Melaleuca* spp.; Jacobs et al. 2017), we did not find many such misidentifications (though there is often little congruency between the molecular and morphological identifications). Our molecular approach could not resolve all taxonomic ambiguities, especially in cases where there was insufficient reference data for vouchers specimens (Parmentier et al. 2013) or short DNA sequence reads available (Stoeckle et al. 2011). This makes differentiation between closely related species difficult. Many of the species in our list (particularly those from Damara

Farm) remained unidentified. This could be because DNA sequencing data for the gene regions that we used are not available for many wattle species and/or because many showed 100% similarity to more than one taxon for the gene regions that were sequenced. We assumed that these results indicated a very closely-related species. There is a need for detailed morphological characterisation to identify these taxa with certainty [colleagues are busy collecting comprehensive herbarium specimens (i.e. with reproductive structures) that will hopefully provide clarity on the species present]. Despite these limitations, our molecular data did yield some interesting results — including identifying new species not previously recorded in South Africa (*A. hakeoides* and *A. ramulosa*); and casting doubt on the identities of three species that have long been included in lists of alien *Acacia* species in the country (*A. adunca*, *A. fimbriata*, *A. floribunda*).

Finally, the misapplication of the name *A. retinodes* for *A. provincialis* that was only uncovered by a reviewer of this manuscript indicates the continuing need for international collaboration with identifications. Such mistakes can lead to confusions with management as *A. retinodes* suckers but *A. provincialis* does not [cf. the misapplication of the name *Melaleuca ericifolia* (a resprouter) to *M. parvistaminea* (a reseeder) — the lack of resprouting in the field was one of the main triggers for a re-evaluation of the identification (Jacobs et al. 2014)].

While the work presented here has not definitely resolved all of the issues around the identity of Australian *Acacia* species in South Africa, it is clear that available inventories of even supposedly well-known taxa can be misleading. Better quantification of current introduction status is crucial for producing effective management strategies and for estimating the resources needed control targeted populations of alien plants (Wilson et al. 2013). They are also essential if we are to have confidence in comparative analyses of invasions.

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Appendix 1

A categorisation scheme for populations according to the Unified Framework for Biological Invasions (adapted from Blackburn et al. 2011).

Category	Definition
A	Not transported beyond limits of native range
B1	Individuals transported beyond limits of the native range, and held in captivity or quarantine (i.e. individuals provided with conditions suitable for them, but explicit measures of containment are in place)
B2	Individuals transported beyond limits of native range, and in cultivation (i.e. individuals provided with conditions suitable for them, but explicit measures to prevent dispersal are limited at best)
B3	Individuals transported beyond limits of the native range, and directly released into novel environment
C0	Individuals released outside of captivity or cultivation in location where introduced, but incapable of surviving for a significant period
C1	Individuals surviving outside of captivity or cultivation in location where introduced, no reproduction
C2	Individuals surviving outside of captivity or cultivation at location where introduced. Reproduction occurring, but population is not self-sustaining
C3	Individuals surviving outside of captivity or cultivation in location where introduced. Reproduction occurring. Population is self-sustaining
D1	Self-sustaining population outside of captivity or cultivation, with individuals surviving a significant distance from the original point of introduction
D2	Self-sustaining population outside of captivity or cultivation, with individuals surviving and reproducing a significant distance from the original point of introduction
E	Fully invasive species, with individual dispersing, surviving and reproducing at multiple sites across a greater or lesser spectrum of habitats and extent of occurrence

Appendix 2

Species status reports for naturalised Australian *Acacia* species (using standardised metrics proposed by Wilson et al. 2014)

Species: *Acacia adunca* G.Don [note molecular work suggests this might be another taxon]

Location: Groot Drakenstein (Bien Donne Farm). South Africa

Status: Naturalised; C3 under Blackburn: Individuals surviving outside of cultivation in location where introduced, reproduction occurring, and population self-sustaining.

Potential: Large proportion of the country is suitable.

Abundance: ~1000 plants (2014); lots of seeds stored in the seedbank

Population Growth Rate: Not known.

Extent: 1 population covering area of 0.27 ha as a closed canopy (i.e. condensed canopy area is also 0.27 ha).

Spread: From its native range, the seeds are spread by animal (ants and birds).

Impact: Has a potential to out-compete indigenous plants. *Acacia adunca* would fail a pre-border assessment as it scores higher than the threshold value of 6 that indicates species as being potentially invasive.

Threat: Not specifically studied, but likely similar to other Australian acacias (see Le Maitre et al. 2011).

Survey method(s) used: Systematic walked transects to generate point distributions. Pamphlets were circulated to land owners. Herbarium specimens and the spotter website, South African Invasive Species, ISpot were examined.

Notes: Eradication plan in place

Contact: invasivespecies@sanbi.org.za

Information compiled by: Nkoliso Magona, nkoliso@sun.ac.za

Species: *Acacia cultriformis* G.Don

Location: Grahamstown (Makana Botanical Garden and Grey Dam).

Status: Naturalised; C3: Individuals surviving outside of cultivation in location where introduced, reproduction occurring, and population self-sustaining.

Potential: Large proportion of the country is suitable.

Abundance: 35 plants (2015).

Population Growth Rate: No seedlings were found during the survey, so nothing is known of population growth rates.

Extent: Two populations covering area of 1.28 ha. (Condensed area of 0.0519 ha).

Spread: In South Africa the species might be spread via seeds by people who are jogging or cycling.

Impact: Has a potential to out-compete indigenous plants. *Acacia cultriformis* would fail a pre-border assessment as it scores higher than the threshold value of 6 that indicates species as being potentially invasive.

Threat: Not specifically studied, but likely similar to other Australian acacias (see Le Maitre et al. 2011).

Survey method(s) used: Systematic walked transects to generate point distributions. Pamphlets were circulated to land owners. Herbarium specimens and the spotter website, South African Invasive Species, ISpot were examined.

Notes: Eradication plan in place.

Contact: nkoliso@sun.ac.za; invasivespecies@sanbi.org.za

Information compiled by: Nkoliso Magona, nkoliso@sun.ac.za

Species: *Acacia fimbriata* G.Don [note molecular work suggests this might be another taxon]

Location: South Africa

Status: Invasive; D2: Self-sustaining population outside of cultivation that is a significant distance from the putative point of introduction.

Potential: Large proportion of the country is suitable.

Abundance: ~5 000 plants (2014); lots of seeds stored in the seedbank.

Population Growth Rate: Not known,

Extent: 3 populations covering area of 53 ha. (Condensed area 0.73 ha)

Spread: In its native range, seeds are spread by animal (ants and birds). It was introduced to botanical garden and now it is found naturalised at the botanic gardens and a waste dumping site (presumably taken there as garden refuse).

Impact: Has the potential to out-compete indigenous plants. *Acacia fimbriata* would fail a pre-border assessment as it scores higher than the threshold value of 6 that indicates species as being potentially invasive.

Threat: Not quantified.

Survey method(s) used: Systematic walked transects to generate point distributions. Pamphlets were circulated to land owners. Herbarium specimens and the spotter website, South African Invasive Species, ISpot were.

Notes: Eradication plan in place

Contact: invasivespecies@sanbi.org.za

Information compiled by: Nkoliso Magona, nkoliso@sun.ac.za

Species: *Acacia piligera* A.Cunn (Fabaceae)

Location: Tokai

Status: Naturalised; C3: Individuals surviving outside of cultivation in location where introduced, reproduction occurring, and population self-sustaining.

Potential: Not quantified.

Abundance: ~174 plants (2015); lot of seeds stored in the seedbank.

Population Growth Rate: Not known, but based on the observed seedling recruitment events occurred after rain and fire, it is believed that water and heat may be the cause of population growth rate.

Extent: One population covering area of 0.0947 ha. (condensed area of 0.0947 ha).

Spread: In its native range, the seeds are dispersed by animals (ants). In South Africa, it has not spread from its original cultivation area.

Impact: Not quantified

Threat: Not specifically studied, but likely similar to other Australian acacias (see Le Maitre et al. 2011).

Survey method(s) used: Systematic walked transects to generate point distributions. Pamphlets were circulated to land owners; herbarium specimens and the spotter website, South African Invasive Species, ISpot were.

Notes: Eradication plan in place.

Contact: invasivespecies@sanbi.org.za

Information compiled by: Nkoliso Magona, nkoliso@sun.ac.za

Species: *Acacia provincialis* A.Camus (*A. retinodes* Schltdl. mis-applied in South Africa) (Fabaceae)

Location: Tokai Arboretum

Status: Naturalised; C3: Individuals surviving outside of cultivation in location where introduced, reproduction occurring, and population self-sustaining.

Potential: A large proportion of the country is suitable for this species.

Abundance: <50 plants (2014); Relatively small seedbanks.

Population Growth Rate: Not known.

Extent: One population covering area of 0.25 ha. (as it is a closed canopy, condensed area is essentially the same, i.e. 0.25 ha)

Spread: In its native range, seeds are dispersed by animals (ants and birds).

Impact: Has the potential to out-compete indigenous plants. *Acacia provincialis* would fail a pre-border assessment as it scores higher than the threshold value of 6 that indicates species as being potentially invasive.

Threat: Not specifically studied, but likely similar to other Australian acacias (see Le Maitre et al. 2011).

Survey method(s) used: Systematic walked transects to generate point distributions. Pamphlets were circulated to land owners. Herbarium specimens and the spotter website, South African Invasive Species, ISpot were examined.

Notes: Eradication plan in place

Contact: invasivespecies@sanbi.org.za

Information compiled by: Nkoliso Magona, nkoliso@sun.ac.za

Species: *Acacia viscidula* Benth. (Fabaceae)

Location: Newlands forest.

Status: Naturalised; C3: Individuals surviving outside of cultivation in location where introduced, reproduction occurring, and population self-sustaining.

Potential: Large proportion of the country is suitable

Abundance: ~1200 plants (2014).

Population Growth Rate: Not known.

Extent: Two populations covering area of 3.5 ha. (Condensed area of 0.077 ha).

Spread: In its native range, seeds are spread by animals (ants and birds).

Impact: Has the potential to out-compete indigenous plants. *Acacia viscidula* would fail a pre-border assessment as it scores higher than the threshold value of 6 that indicates species as being potentially invasive.

Threat: Not specifically studied, but likely similar to other Australian acacias (see Le Maitre et al., 2011).

Survey method(s) used: Systematic walked transects to generate point distributions. Pamphlets were circulated to land owners. Herbarium specimens and the spotter website, South African Invasive Species, ISpot were examined.

Notes: Eradication plan in place. Plants are vigorous resprouters

Contact: invasivespecies@sanbi.org.za

Information compiled by: Nkoliso Magona, nkoliso@sun.ac.za

Supplementary material 1

Molecular and morphological assessments for the identity of Australian Acacia species collected in South Africa: a) from naturalised populations not previously assessed; and b) from Damara Farm near Malmesbury in South Africa

Authors: Nkoliso Magona, David M. Richardson, Johannes J. Le Roux, Suzaan Kritzinger-Klopper, John R. U. Wilson

Data type: Table linking linking samples to Genbank accession numbers.

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Link: https://doi.org/10.3897/neobiota.39.23135.suppl1

Supplementary material 2

South African herbarium accession numbers for specimens that were not available online at http://newposa.sanbi.org as of 1 March 2018

Authors: Nkoliso Magona, David M. Richardson, Johannes J. Le Roux, Suzaan Kritzinger-Klopper, John R. U. Wilson

Data type: Table of species and corresponding herbarium numbers.

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Link: https://doi.org/10.3897/neobiota.39.23135.suppl2

Supplementary material 3

Records of naturalised populations of wattles as per the Southern African Plant Invaders Atlas (date accessed: January 2017)

Authors: Nkoliso Magona, David M. Richardson, Johannes J. Le Roux, Suzaan Kritzinger-Klopper, John R. U. Wilson

Data type: Table of species occurrences.

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Link: https://doi.org/10.3897/neobiota.39.23135.suppl3

Supplementary material 4

Details of the forestry trial at Damara Farm, South Africa, that included many species of wattles not previously recorded from South Africa

Authors: Nkoliso Magona, David M. Richardson, Johannes J. Le Roux, Suzaan Kritzinger-Klopper, John R. U. Wilson

Data type: Site description.

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